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## (54) Display apparatus characterized by board-supporting structure

(57) A display apparatus is constituted by a display panel having an electrode terminal, a flexible carrier carrying a drive element for driving the display panel together with an input terminal and an output terminal connected thereto, a circuit board for supplying signals to the drive element, and a support plate for supporting the display panel and the circuit board. The output terminal and the input terminal of the flexible carrier are connected to the electrode terminal of the display panel and the

circuit board, respectively. The support plate is provided with a supporting member, for supporting the circuit board at a position which is farther from the display panel than a line dividing the circuit board into equal halves closer to and farther from the display panel. As a result, when the display apparatus is supplied with an impact in a direction perpendicular thereto, the circuit board is allowed to rotate so as to reduce a stress applied to the flexible carrier, thereby preventing the breakage or electrical connection failure thereof.

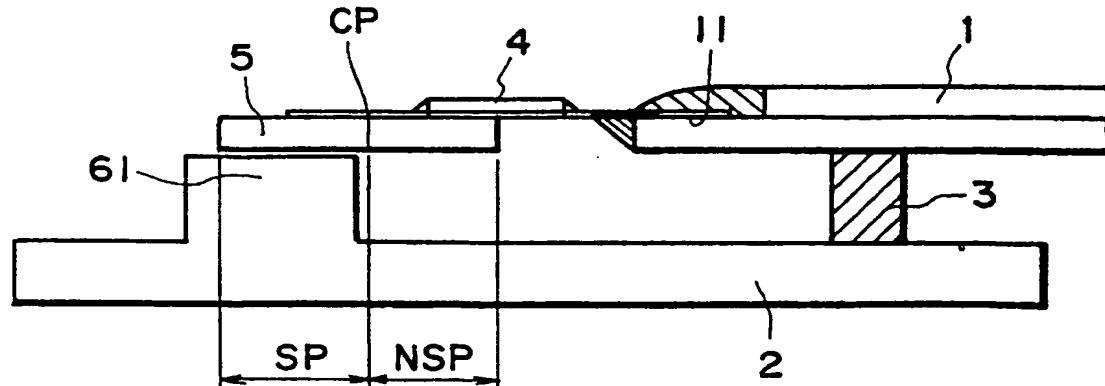


FIG. 2

## Description

The present invention relates to a display apparatus for use in a television receiver, a view finder for a video camera, a computer display, a navigation system, etc., particularly a display apparatus characterized by a supporting structure for a circuit board for driving a display panel.

A display apparatus has a planar structure, e.g., as shown in Figure 8. A display panel 1 is constituted by disposing a liquid crystal between a pair of glass substrates each having thereon a polarizer film (not shown). A driver IC 4a for liquid crystal device is mounted on a tape carrier 4 comprising a flexible substrate by a TAB (type automated bonding) scheme. Such a package of IC is called a TCP (tape carrier package). The TCP 4 is electrically connected to a display panel 1 and a circuit board 5, which is a rigid board for supplying signals to a driver IC 4a.

Further, as shown in Figure 8, connection electrodes 11 of the liquid crystal panel 1 are connected to output-side outer leads of the carrier 4, and input-side outer leads 41 are connected to electrodes of a circuit board 5. The circuit boards 5 are fixed to a panel-fixing plate 2 by holding plates 64.

Figures 9 and 10 are sectional views taken along a line C-C and a line D-D, respectively, in Figure 8. An adhesive 3 is applied onto a periphery of the panel fixing plate 2, and a liquid crystal panel 1 is disposed thereon to be fixed by bonding. Therefore, edges of the circuit board 5 are fixed by means of the holding plate 64 onto the panel-fixing plate 2. The panel-fixing plate 2 is provided with a rib 63 for supporting the circuit board 5.

A display apparatus having the above-mentioned structure is however accompanied with the following problems to be solved.

When an impact is applied to the display apparatus in +Y direction as shown in Figure 11, the liquid crystal panel 1 is also caused to move in the +Y direction, so that the panel-fixing plate 2 is deformed in an arcuate form to compress the adhesive 3 as shown. Corresponding to the deformation of the panel-fixing plate 2 and the compression of the adhesive 3, a relative position between the liquid crystal panel 1 and the circuit board 5 respectively connected to the panel-fixing plate 2 is changed. The flexible substrate 4 of the TCP tends to deform to absorb the positional change but can be broken in some cases as shown at f in Figure 11 because of a large positional change.

Further, due to an impact or vibration, the circuit board per se can be deformed to apply a stress to the TCP to cause a breakage thereof.

An object of one aspect of the present invention is to provide a display apparatus provided with a circuit board-supporting structure not liable to break a tape carrier package (TCP) due to an impact or vibration applied thereto.

According to the present invention, there is provid-

ed a display apparatus, comprising: a display panel having an electrode terminal, a flexible carrier carrying a drive element for driving the display panel together with an input terminal and an output terminal connected thereto, a circuit board for supplying signals to the drive element, and a support plate for supporting the display panel and the circuit board, the output terminal and the input terminal of the flexible carrier being connected to the electrode terminal of the display panel and the circuit board, respectively;

wherein the support plate is provided with a supporting member for supporting the circuit board at a position which is farther from the display panel than a line dividing the circuit board into equal halves closer to and 15 farther from the display panel.

In this instance, the supporting member may preferably be provided as at least three projections which may be disposed between adjacent flexible carriers or directly below the input terminal of a flexible carrier.

Further, in one embodiment of the present invention, it is appropriate to provide a regulation member for regulating the movement of the circuit board at a position opposite to the supporting member via the circuit board. The regulation member may preferably be provided to a housing member disposed above the display panel. The regulation member may preferably be composed of an elastic member.

Further, a slight gap may be provided between the circuit board and the regulation member.

The display apparatus according to the present invention may preferably be constituted as a liquid crystal display apparatus.

According to the present invention, there is provided a display apparatus having a high reliability wherein the circuit board is inclined when a strong impact or vibration is applied to the display panel, thereby preventing a breakage of TCP or a separation of an electrical

Embodiments of the present invention will now be described with reference to the accompanying drawings 40 in which:-

Figure 1 is a plan view of a liquid crystal display apparatus according to an embodiment of the invention.

Figure 2 is a sectional view taken along a line A-A in Figure 1.

Figure 3 is also a sectional view taken along a line A-A in Figure 1 including members not shown in Figure 1.

Figure 4 is a sectional illustration for illustrating a state when an impact is applied in a +Y direction to the liquid crystal display apparatus.

Figure 5 is a sectional illustration for illustrating a state when an impact is applied in a -Y direction to the liquid crystal display apparatus.

Figure 6 is a sectional view taken along a line B-B in Figure 1.

Figure 7 is also a sectional view taken along a line B-B in Figure 1 including members not shown in Figure 1..

Figure 8 is a plan view of a liquid crystal display apparatus.

Figure 9 is a sectional view taken along a line C-C in Figure 8.

Figure 10 is a sectional view taken along a line D-D in Figure 8.

Figure 11 is a schematic sectional view for illustrating a state when an external force is applied to the liquid crystal display apparatus shown in Figure 8 in a +Y direction.

Referring to Figure 1, a display panel 1 is constituted by disposing a liquid crystal between a pair of substrates, e.g., composed of glass, each having on their inner sides contacting the liquid crystal a group of electrodes and having on their outer sides polarizer films (not shown). Driver ICs 4a for driving the display panel are mounted on flexible tape carriers 4 and electrically connected to the display panel 1 and the circuit board 5, which is a rigid board for supplying electric signals, such as a reference voltage, clock signals, image signals and control signals to the driver ICs 4a.

Connection electrodes 11 of the display panel 1 are connected to output-side outer leads (output terminals) of the carrier 4, and input-side outer leads (input terminals) 41 are connected to the electrodes of the circuit board 5. In the embodiment shown in Figure 1, the holding plates 64 used in the device of Figures 9 to 11 are not used.

Some characteristic features of this embodiment are described with reference to Figure 2 which is a sectional view taken along a line A-A in Figure 1, and Figure 3 which is a corresponding view showing a state further covered with a face plate-supporting member 10.

Referring to Figure 2, a display panel 1 is disposed on an elastic member 3 which in turn is disposed on an upper surface of a panel-fixing plate 2. The elastic member 3 is fixedly disposed on the panel-fixing plate 2 so as to surround the four sides of a display area of the panel 1. The fixing structure may be formed by applying an elastic adhesive which shows elasticity after the curing in a frame-shape and disposing thereon the display panel 1, followed by curing of the adhesive. Further, the panel-fixing plate 2 is provided with a rib 61 as a supporting member at such a position as to support a circuit board disposed thereon with (a portion of) a half region SP thereof disposed farther from the panel 1 with respect to a line CP extending in a direction of arrangement of electrode terminals of the display panel 1 and dividing the circuit board 5 into equal halves (SP and NSP). The remaining half region NSP of the circuit board 5 is provided with no supporting member.

Further, as shown in Figure 3, a face plate 9 is disposed above the display panel 1. The face plate 9 is fixed to a face plate-supporting member 10, which in turn is fixed to the panel-fixing plate 2. The face plate-supporting member 10 is provided with an elastic member 62 (as a regulation member) at a position corresponding to the region SP of the circuit board 5 which

is disposed farther from the panel 1 with respect to the above-mentioned drive CP driving the circuit board 5 into equal halves in a direction parallel to the direction of arrangement of the electrode terminals of the display panel 1. The elastic member 62 is disposed above and with a gap from the circuit board 5 so as to regulate or restrict an upward movement of the circuit board 5.

Same effects of the above-described arrangement will now be described with reference to Figures 4 and 5. For example, when a dropping impact is applied in a +Y direction to the display apparatus, the display panel 1 is supplied with a load to move in the +Y direction and simultaneously the panel-fixing plate 2 is deformed in an arcuate form to compress the adhesive 3 as shown in Figure 4.

At this time, due to the deformation of the panel-fixing plate 2 and the compression of the adhesive 3, a relative position between the display panel 1 fixed to the panel-fixing plate 2 and the circuit board 5 is changed.

However, as the rib 61 supporting the circuit board 5 is disposed in the region SP which is farther from the display panel 1 with respect to the line CP driving the circuit board 5 into equal halves in the direction of arrangement of the terminal electrodes 11 of the display panel 1, the circuit board is allowed to slidably rotate about the edge of the rib 61 as a fulcrum. As a result, it becomes possible to prevent the breakage of the TCP or separation of the connection.

The supporting member may preferably be composed of a plurality of ribs 61 arranged discretely in the longitudinal direction of the circuit board 5. An arrangement example thereof is illustrated in Figures 6 and 7. Referring to these figures, a rib 61 as described above is disposed not only at both ends of the circuit board 5 in the direction of arrangement of the terminal electrodes 11 (i.e., in the longitudinal direction of the circuit board 5) but also at a central position of the circuit board 5. As a result, the deformation of the circuit board in the longitudinal direction is reduced.

Further, also in the case of a dropping impact in the -Y direction, the circuit board is allowed to rotate because of the above-mentioned specified position in the region SP of the elastic member 62, the circuit board 5 is allowed to rotate upward (counterclockwise) as shown in Figure 5. As a result, it becomes possible to reduce a flexural deformation of the TCP per se and a stress applied thereto, thereby preventing the breakage of the TCP and the occurrence of connection failure.

Similarly as the supporting member 61, if the elastic member 62 is disposed not only at both ends but also at a central portion of the circuit board 5, it is possible to reduce the deformation of the circuit board 5 per se along the longitudinal direction thereof and minimize the stress applied to the TCP, thus effectively preventing the breakage.

Further, by disposing an elastic member 62 between an adjacent pair of TCPs 4 in a display apparatus including a plurality of TCPs disposed on a side of the

display panel 1, it is possible to obviate a collision or contact between a TCP 4 and an elastic member 62, thereby avoiding an unnecessary stress applied to the TCP 4. Further, by disposing the supporting member 61 and the elastic member (regulation member) 62 directly below or above the input terminals 41 of the TCP 4, these members may be disposed without narrowing a region for mounting drive elements on the TCPs 4 and the circuit board 5. As the supporting member 61 and the regulation member 62 are disposed with a spacing which is larger than the thickness of the circuit board 5, so that a gap is ensured to remain between the circuit board 5 and one of the supporting member 61 and the regulation member 62.

As a result, the movement of the circuit board 5 is restricted in the  $\pm Y$  directions than in the  $\pm X$  directions and in the  $\pm Z$  directions. Thus, when the panel 1 is moved in the  $\pm X$  or  $\pm Z$  direction due to an impact applied thereto, the circuit board 5 is also moved in the  $\pm X$  or  $\pm Z$  direction. However, the movement of the circuit board 5 in the  $\pm Y$  direction is restricted, so that the circuit board 5 is moved in accompaniment with the display panel 1, and a relative position therebetween is not readily changed, to effectively prevent the breakage of the TCPs and the occurrence of connection failure.

The liquid crystal material used in the display panel 1 may comprise a chiral smectic liquid crystal showing ferroelectricity or antiferroelectricity, a nematic liquid crystal or a chiral nematic liquid crystal.

In the above embodiment, the elastic member 3 between the display panel 1 and the panel-fixing plate 2 is formed by bonding the display panel 1 and the panel-fixing plate 2 with a cured adhesive of silicone rubber-type, but the manner of production and fixation need not be limited thereto.

Further, the panel-fixing plate 2 may be replaced by a backlight unit, which may be of a direct backing-type, or a side light-type (edge light-type) using a solid light guide member, such as an acrylic resin plate, or a hollow light guide space.

The materials including hardness of the rib 61 provided to the panel-fixing plate 2 and the regulation member (preferably an elastic member) 61 provided between the face plate-supporting number 10 and the circuit board 5, need not be particularly limited.

The face plate 9 may preferably be disposed above the display panel 1 but can be omitted.

As described above, according to the present invention, it is possible to obviate the breakage of a TCP or the occurrence of electrical connection failure thereof even when a strong impact or vibration is applied to a display apparatus. Further, by holding or supporting a circuit board with a small gap with an upper or lower supporting member, it is possible to alleviate the breakage of a TCP fixed to the circuit board or the occurrence of electrical connection failure thereof even when the display panel is moved in horizontal directions due to an impact application.

## Claims

1. A display apparatus, comprising: a display panel having an electrode terminal, a flexible carrier carrying a drive element for driving the display panel together with an input terminal and an output terminal connected thereto, a circuit board for supplying signals to the drive element, and a support plate for supporting the display panel and the circuit board, the output terminal and the input terminal of the flexible carrier being connected to the electrode terminal of the display panel and the circuit board, respectively;
  - 5 wherein the support plate is provided with a supporting member for supporting the circuit board at a position which is farther from the display panel than a line dividing the circuit board into equal halves closer to and farther from the display panel.
2. A display apparatus according to Claim 1, wherein the supporting member is provided as at least three projections formed on the support plate.
3. A display apparatus according to Claim 1 or 2, wherein the supporting member is disposed between adjacent flexible carriers.
4. A display apparatus according to Claim 1 or 2, wherein said supporting member is disposed directly below the input terminal of the flexible carrier.
5. A display apparatus according to Claim 1, wherein a regulation member for regulating a movement of the circuit board is disposed at a position opposite to the supporting member so as to sandwich the circuit board together with the supporting member.
6. A display apparatus according to Claim 5, wherein said regulation member is provided to a support member for supporting a face plate disposed above the display panel.
7. A display apparatus according to Claim 5 or 6, wherein said supporting member or regulation member is composed of an elastic member.
8. A display apparatus according to any one of Claims 1 - 7, wherein a gap is formed between the circuit board and the regulation member.
9. A display apparatus according to any preceding claim, wherein said display panel comprises a liquid crystal panel.
- 55 10. A display apparatus according to Claim 9, wherein said liquid panel comprises a pair of substrates and a chiral smectic liquid crystal disposed between the substrates.

11. A display apparatus comprising a display panel mounted to be displaceable by an impact, at least one circuit board for supplying signals to said display panel, a flexible support for providing flexible electrical connections between said circuit board and said display panel, at least one support for supporting said at least one circuit board to allow said circuit board to pivot about an intermediate point, such as half way along, when said display panel is displaced.

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12. A display apparatus as claimed in claim 11 wherein said at least one circuit board is supported at a portion thereof by said at least one support, such that said at least one circuit board pivots about an edge of said at least one support.

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13. A display apparatus as claimed in claim 11 or claim 12 wherein the pivotal motion of said at least one circuit board is limited by at least one elastic member.

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14. A display apparatus as claimed in any one of claims 11 to 13 wherein said display panel is mounted on at least one elastic member.

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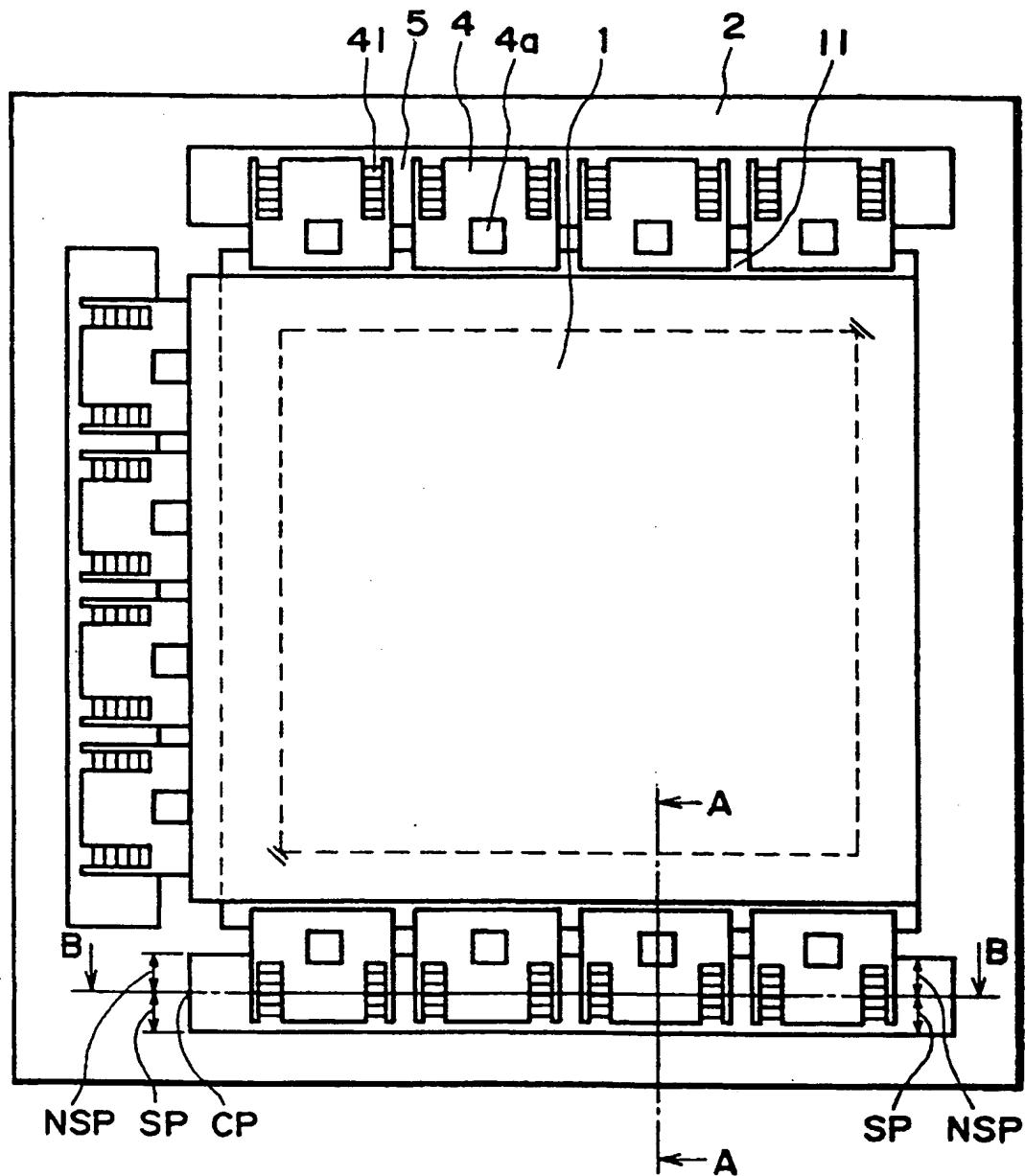


FIG. I

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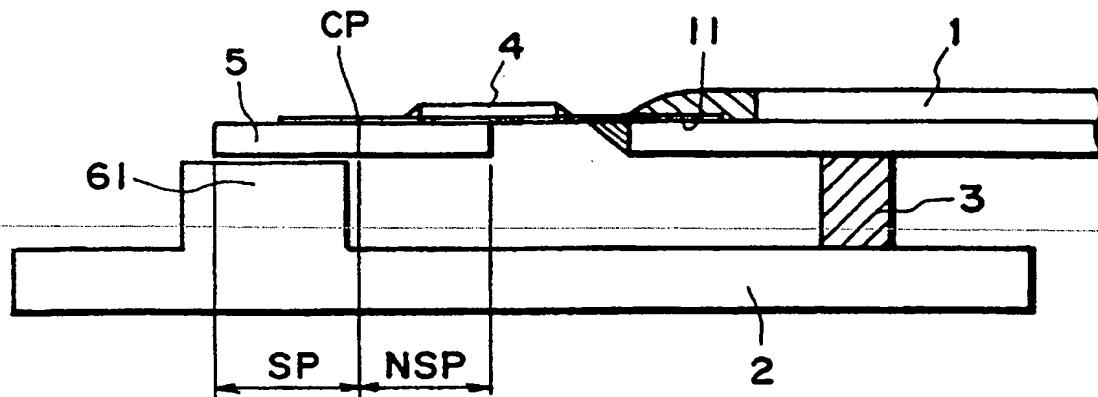


FIG. 2

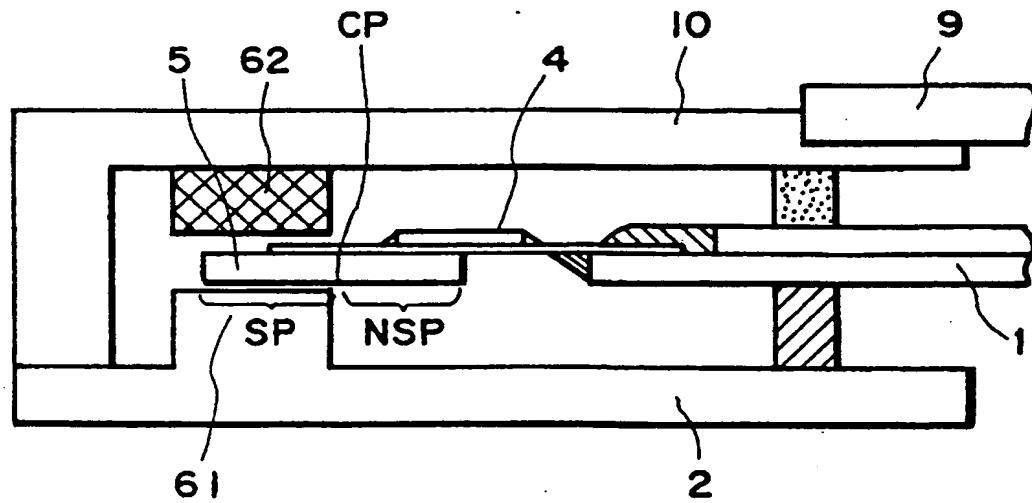


FIG. 3

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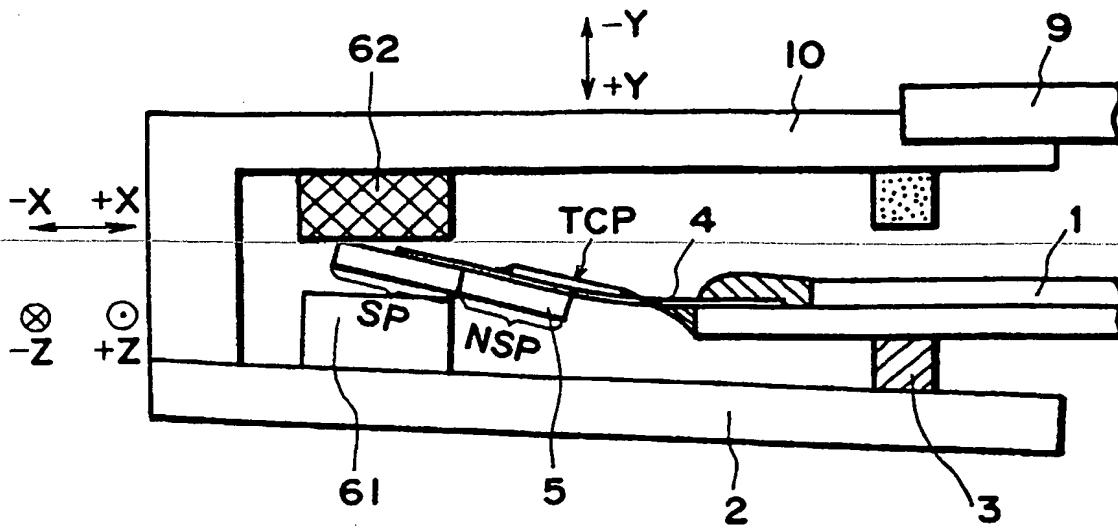


FIG. 4

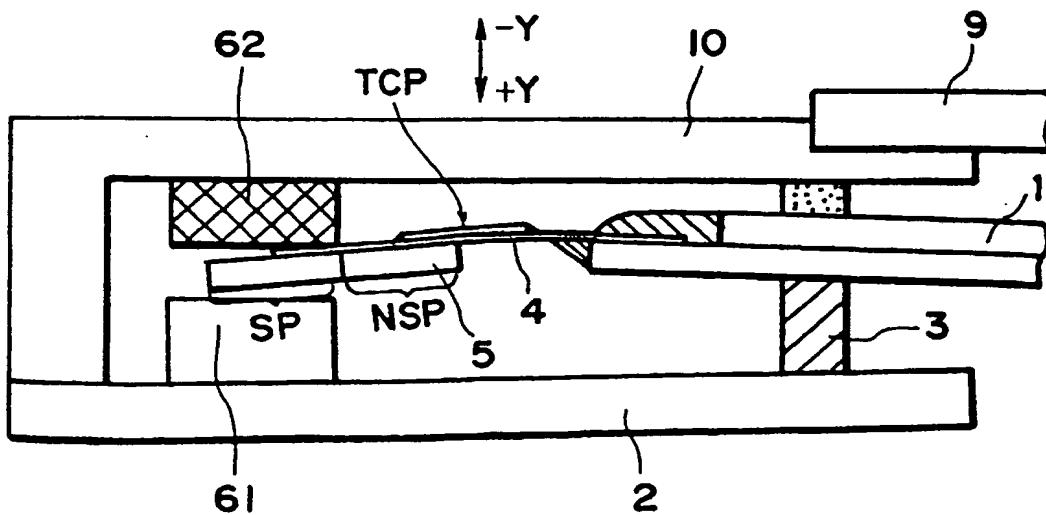


FIG. 5

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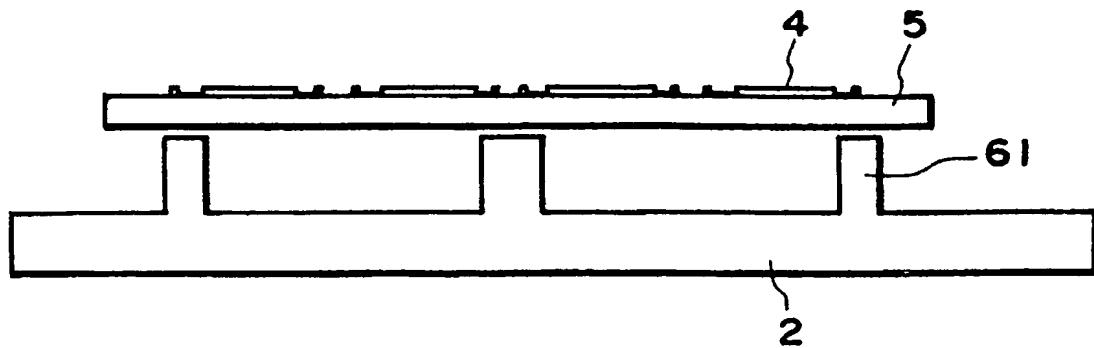


FIG. 6

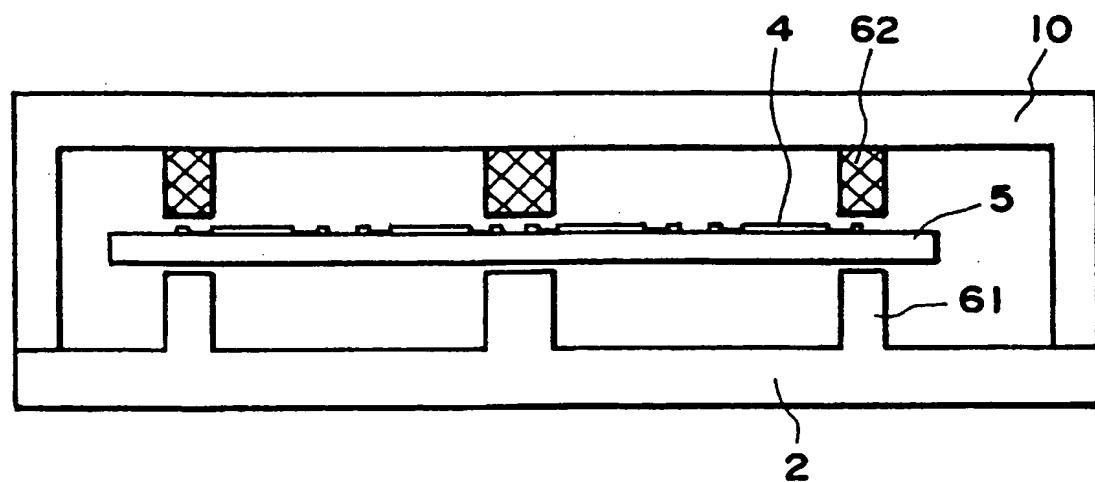


FIG. 7

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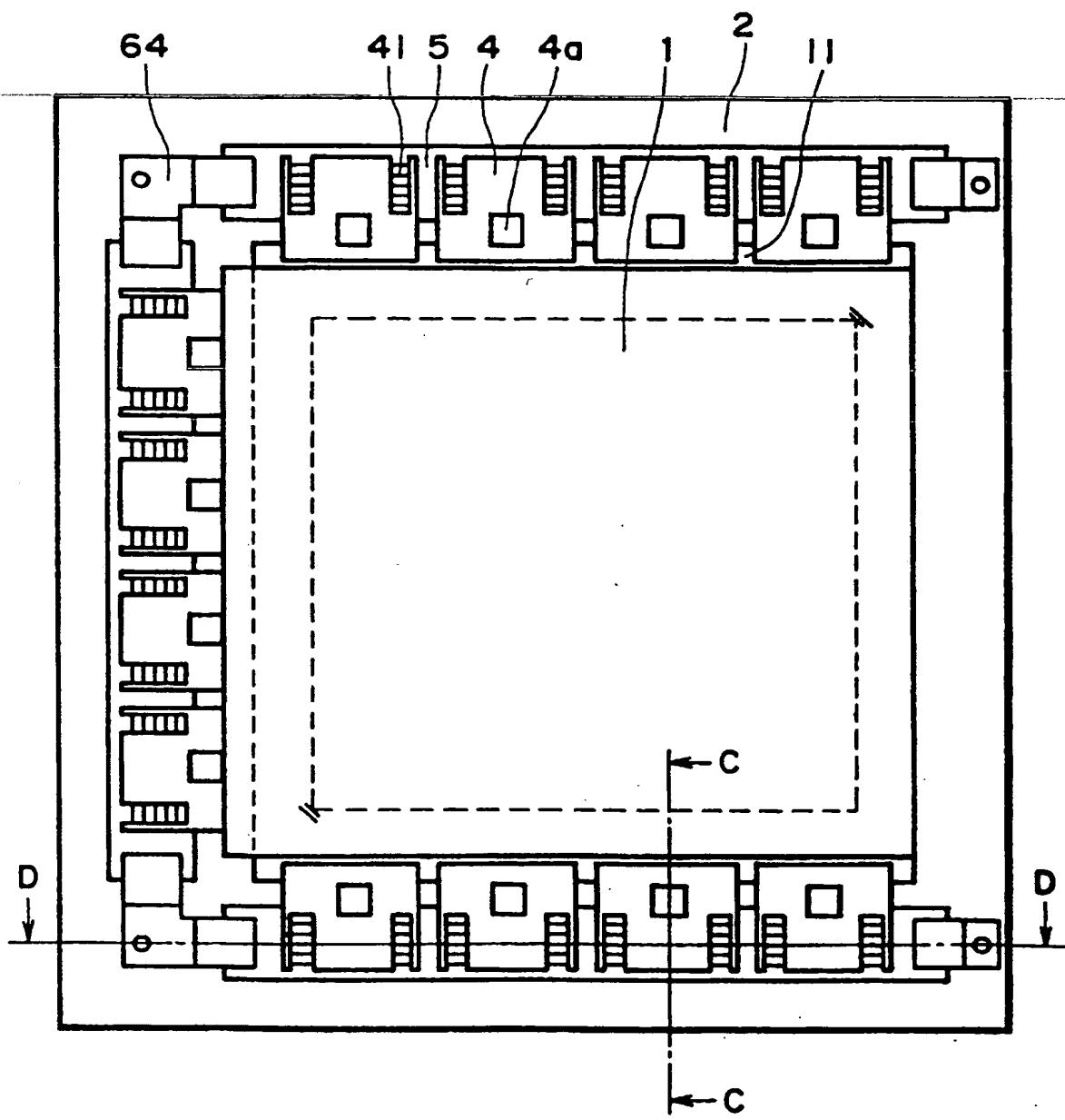


FIG. 8

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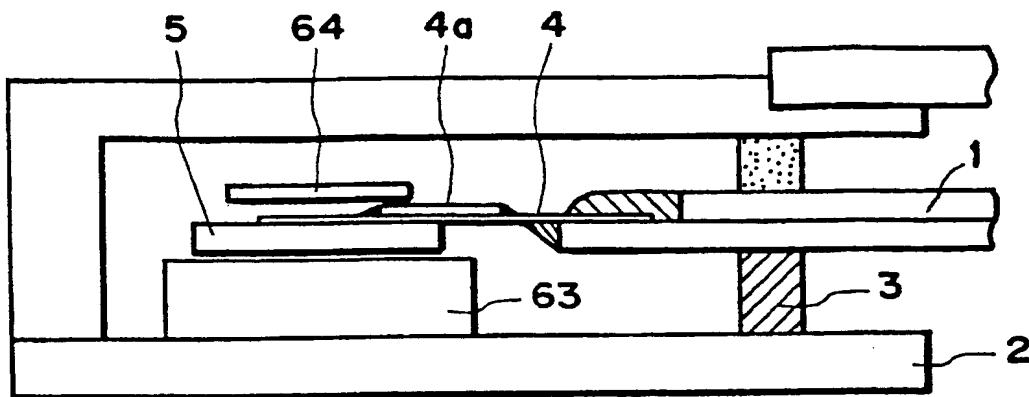


FIG. 9

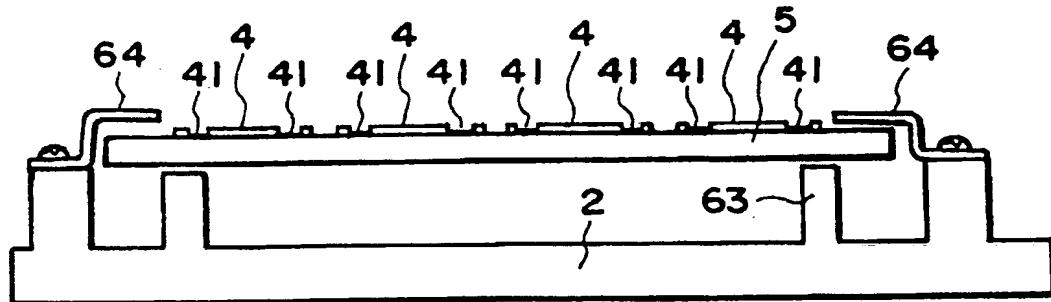


FIG. 10

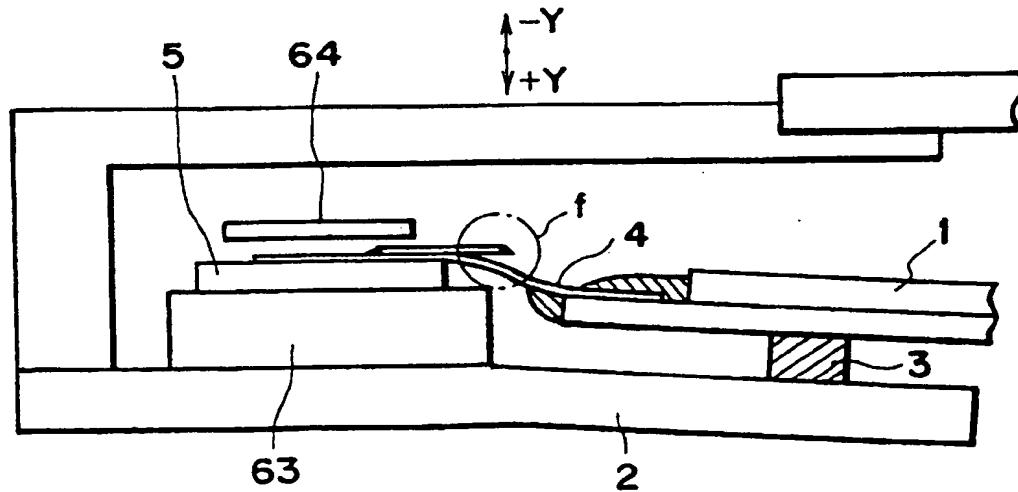


FIG. 11

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